AEROSPACE INFORMATION REPORT

AIR6211™	REV. B

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Cancelled 2022-10

Superseded by AS6211

Ice Penetration Test Method for Runways and Taxiways Deicing/Anti-Icing Chemicals

RATIONALE

This SAE Aerospace Information Report AIR6211 does not fit the definition of an AIR document; therefore, it is cancelled and superseded by the SAE Aerospace Standard document AS6211, which contains specific test methods and protocols. The new SAE Aerospace Standard document contains additional information on the preparation of reference control solutions. The new document also incorporates some editorial changes.

CANCELLATION NOTICE

This Technical Report has been declared “CANCELLED” as of October 2022 and has been superseded by AS6211. By this action, this document will remain listed in the respective index, if applicable. Cancelled Technical Reports are available from SAE.

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https://www.sae.org/standards/content/AIR6211B/

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1. SCOPE

This test method provides stakeholders (runway deicing chemical manufacturers, users, regulators, and airport authorities) with a relative ice penetration capacity of runway deicing/anti-icing chemicals, by measuring the ice penetration as a function of time. Such runway deicing/anti-icing chemicals are often also used on taxiways and other paved areas.

This test method does not quantitatively measure the theoretical or extended time of ice penetration capability of ready-to-use runway deicing/anti-icing chemicals in liquid or solid form.

1.1 Minimum Requirements

This method sets the minimum testing requirements for the determination of ice penetration capabilities of AMS1431 and AMS1435 runway deicing/anti-icing chemicals in liquid and solid form as a function of time and temperature, under controlled laboratory conditions.

1.2 Hazardous Materials

This test may involve the use of hazardous materials, operations, and equipment. This standard does not address the safety problems associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1.3 Standard Units

The values stated in SI units are to be regarded as the standard.

2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS1431 Compound, Solid Runway and Taxiway Deicing/Anti-Icing

AMS1435 Fluid, Generic, Deicing/Anti-Icing Runways and Taxiways

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D1193 Specification for Reagent Water

ASTM D1747 Refractive Index of Viscous Materials

2.3 ISO Publications

Available from International Organization for Standardization, ISO Central Secretariat, 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, Tel: +41 22 749 01 11, www.iso.org.

ISO 9001-2008 Quality Management Systems – Requirements

2.4 Other Reference Documents

Handbook of Test Methods for Evaluating Chemical Deicers, Strategic Highway Research Program, National Research Council Washington, DC 1992, SHRP-H-332.

3. SUMMARY OF TEST METHOD

3.1 Introduction

This test utilizes an adapted test support having 4.0 mm (0.16 inch) inside diameter small glass test tubes filled with ice. After equilibration to the desired test temperature, a known volume of dyed-liquid runway deicing/anti-icing chemical is discharged onto the ice surface and penetration commences (see Figure 1). At specified time intervals, the length of penetration is measured. Testing temperatures shall be within 0.5 °C (1 °F) of the stated values and tests shall be performed within a freezer or a cold chamber.

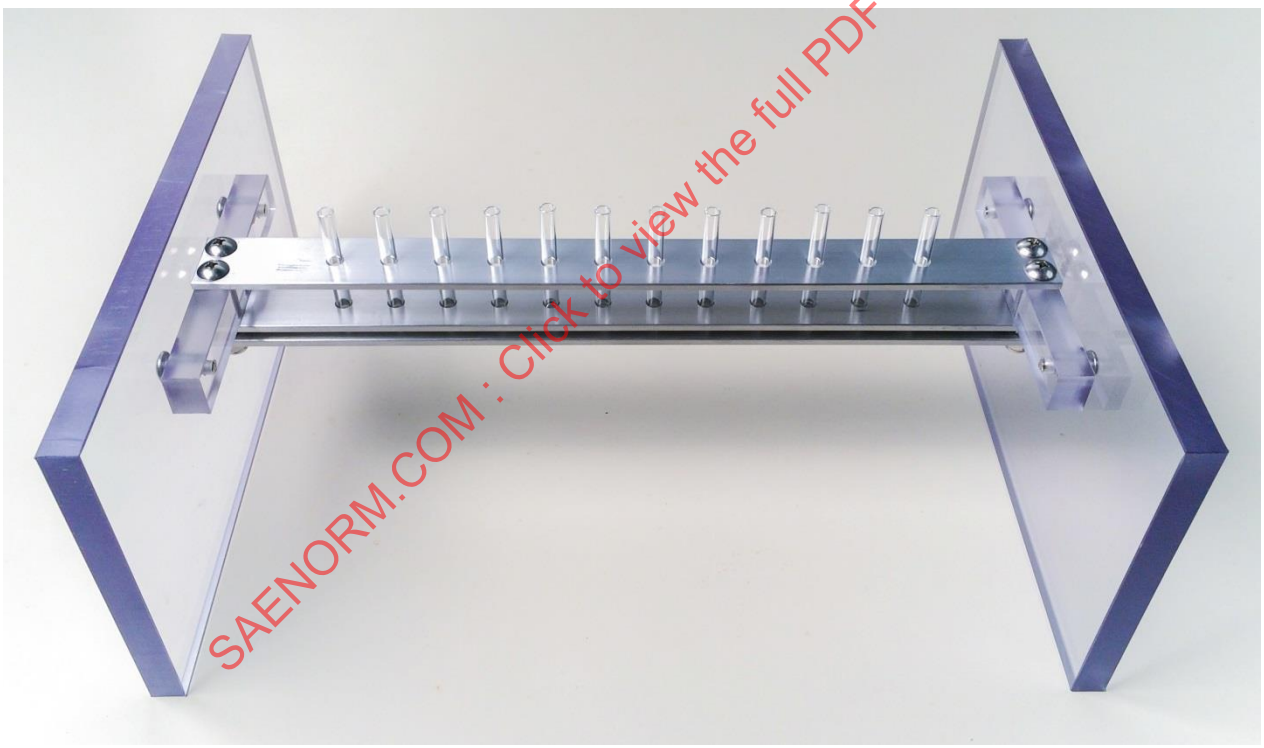

Figure 1 - Example of adapted test support with glass test tubes

3.2 Significance and Use

This test method can be used to evaluate and compare the ice penetrating capabilities of runway deicing/anti-icing chemicals in liquid or solid form over a limited, defined time interval at specified temperatures.

3.3 Test Equipment and Materials

The following test procedure may be performed on runway deicing/anti-icing chemicals in liquid or solid form.

3.3.1 Material

a. Adapted test support

b. Aluminum rod (6061-T6 alloy): 3.75 mm ± 0.10 mm (0.148 inch ± 0.004 inch) diameter

c. Pipettor (single or multichannel pipettor) able to deliver a volume of 25.0 µL ± 0.3 µL

d. Plastic syringe with needle (capacity 1 mL)

e. Micro centrifuge tubes, 1.5 mL graduated; e.g., Fisherbrand cat # 02-682-550 (or equivalent)

f. Pyrex® Tube, Culture, 6 mm x 50 mm, Rimless test tube part # 70820-6, Corning Incorporated. 0.5 mL volume, 6 mm (0.24 inch) OD, 4.0 mm (0.16 inch) ID.

g. Digital thermometer (or equivalent)

h. Digital timer (or equivalent)

i. Micrometer, rule or equivalent

j. Refrigerator or room to store the material at 4 °C ± 1 °C (39 °F ± 2 °F)

k. Cold room or freezer having a temperature control within ±0.5 °C (±1 °F)

l. Rhodamine or fluorescein 0.1% (w/v) solution (other dyes can be used provided that it is clearly specified)

m. Balance (precision ±0.001 g)

n. ASTM D1193, Type IV water

3.3.2 Adapted Test Support

This section describes a typical adapted test support, however, any other equivalent device can be used. The ice penetration test apparatus consists of three parallel rectangular aluminum flat bars of 305 mm (12 inches) long x 25.4 mm (1.0 inch) wide x 3.18 mm (0.125 inch) thick. The three flat bars are vertically aligned. Twelve 5.72 mm (0.225 inch) diameter holes are drilled in the center of the two upper plates at 19 mm (0.750 inch) spacings center to center. The three aluminum flat bars are seated and maintained together using two rectangular Plexiglas® pieces which act as stabilization device. Figure 2 shows a detailed typical example of an adapted test support including dimensions to scale. The ice penetration test apparatus also includes a 3.75 mm (0.148 inch) diameter aluminum rod which is used for the ice preparation (see Figure 3 for dimension details). A timer, preferably a digital timer that can be activated at test start, is required.

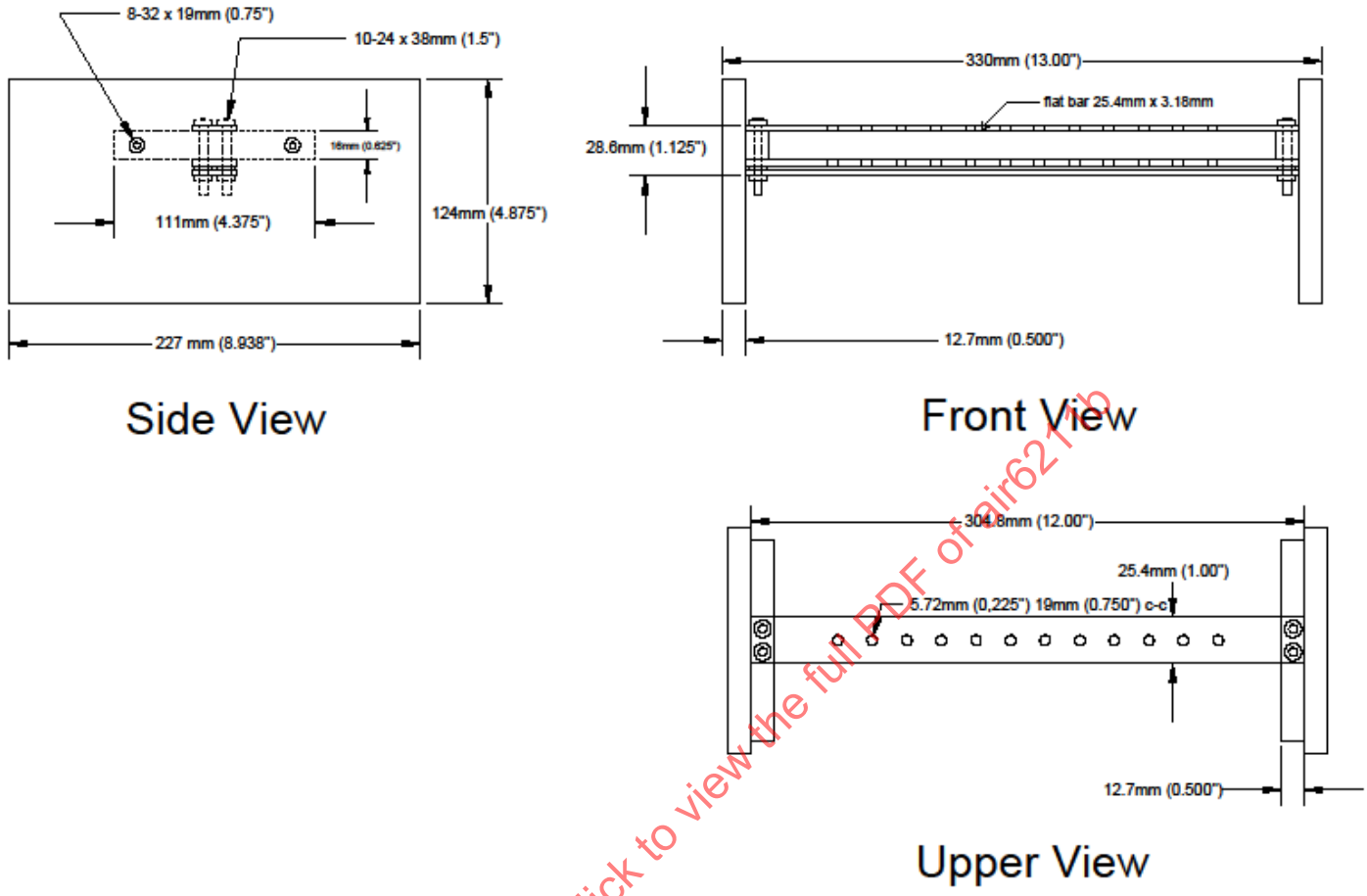

Figure 2 - Adapted test support dimensions to scale

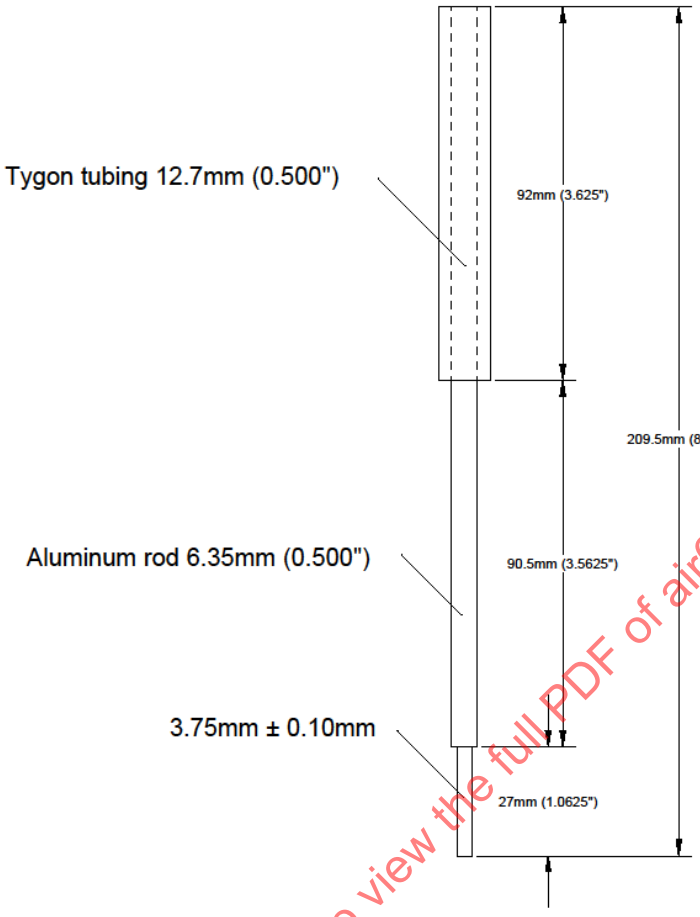

Figure 3 - Aluminum rod dimensions to scale

3.3.3 Standard Measuring Devices

All temperature sensors, electronic balances, and timing devices shall be maintained in a known state of calibration by means of a Quality Management System recognized by an international standards organization such as ISO 9001-2008 (or equivalent).

3.3.4 Ice Preparation

ASTM D1193 Type IV water has to be used for the ice preparation. Water, adapted test support, glass test tubes, and material required for the ice preparation have to be kept at 4 °C ± 1 °C (39 °F ± 2 °F) for a minimum period of 8 hours prior to preparing the ice. Place the adapted test support and glass test tubes (separately) into the cold chamber at -10.0 °C ± 0.5 °C (14 °F ± 1 °F) for 15 minutes. Then, the test support with test tubes in place is adjusted in a horizontal position. The pre-cooled water is drawn into a syringe, the needle inserted into test tubes bottom, and the test tubes filled with 0.4 mL of water while withdrawing the needle. Bubbles in the water column (usually none) should be forced out if necessary. Depending on the adapted test support and measuring device used, it could be more convenient to fill the test tubes with 0.45 or 0.5 mL of water.

The ice penetration test apparatus as prepared above and the syringe is kept at -10.0 °C ± 0.5 °C (14 °F ± 1 °F) for 2 hours. After that period, the adapted test support must be kept in the cold room (freezer) and proceed as follows: if water undercooling is observed, initiate the ice formation by gently touching the water surface using a needle. The ice penetration test apparatus is kept at -10.0 °C ± 0.5 °C (14 °F ± 1 °F) for an additional 30 minute period. When the ice is formed, melt the rough ice surface using the 3.75 mm diameter aluminum rod, pre-heated in hot water at 65 to 70 °C (149 to 158 °F). Finally, the ice penetration test apparatus is left in the constant temperature chamber at -10.0 °C ± 0.5 °C (14 °F ± 1 °F) for an additional 1.5 hours before to perform the ice penetration test.

3.4 General Test Procedures

The test procedure depends on the runway deicing/anti-icing chemicals form (liquid or solid).

3.4.1 Liquid Runway Deicing/Anti-Icing Chemical

Liquid runway deicing/anti-icing chemical shall be evaluated as supplied. No dilution or preparation is needed prior to the test.

3.4.2 Solid Runway Deicing/Anti-Icing Chemical

Solid runway deicing/anti-icing chemical must be diluted to give a 25% w/w solution. To obtain this 25% w/w solution, dissolve "x" g ± 0.1 g of solid runway deicing/anti-icing chemical in "3x" g ± 0.1 g of ASTM D1193, Type IV water. For example, if x = 5 g, 3x is 15 g, for a final weigh of 20 g of a 25% w/w solution of a given solid runway deicing/anti-icing chemical.

3.4.3 Reference Control Solution

A reference control solution shall be tested along with the runway deicing/anti-icing chemical. The results are used as a test control and as an optional comparative test. The reference solution consists of a reagent grade ACS >99% potassium acetate (KAC) solution prepared with ASTM D1193, Type IV water.

3.4.3.1 Liquid Runway Deicing/Anti-Icing Chemical

The 50% w/w reference control solution is prepared by mixing "x" g ± 0.1 g of KAC and "x" g ± 0.1 g of ASTM D1193, Type IV water and is calculated according to Equation 1:

$$\%\,w/w = \left(\frac{x\,g\,CH_3CO_2K}{x\,g\,CH_3CO_2K + x\,g\,H_2O} \right) * 100 \qquad \text{(Eq. 1)}$$

where:

CH_3CO_2K = potassium acetate (reagent grade ACS >99%)

H_2O = water (ASTM D1193, Type IV)

3.4.3.2 Solid Runway Deicing/Anti-icing Chemical

The reference control solution for solid runway deicing/anti-icing chemical consists of a 25% w/w KAC solution.

The 25% w/w reference control solution is prepared by mixing "x" g ± 0.1 g of KAC and "x" g ± 0.1 g of ASTM D1193, Type IV water, and is calculated according to Equation 2:

$$\%\,w/w = \left(\frac{x\,g\,CH_3CO_2K}{x\,g\,CH_3CO_2K + 3x\,g\,H_2O} \right) * 100 \qquad \text{(Eq. 2)}$$

where:

CH_3CO_2K = potassium acetate (reagent grade ACS >99%)

H_2O = water (ASTM D1193, Type IV)

3.4.4 Incorporation of Dye

If the liquid runway deicing/anti-icing chemical or the 25% w/w dilution of solid runway deicing/anti-icing chemical do not have a vivid enough color (strength) to accurately report the ice penetration capability, a dye shall be prepared and added as follows:

a. Two dyes are recommended to perform the test; the rhodamine B (CAS #81-88-9) and the florescein (CAS #518-47-8). Both dyes can be used: however, the rhodamine B should be prioritized since it shows better contrast and facilitates the ice penetration measurement. The dye should be chosen so that there are no compatibility issues with the different runway deicing/anti-icing chemical chemistries. The dye used for the test should be specified and agreed accordingly.

b. The dye shall be diluted to 0.1% weight by volume (0.1% w/v) in ASTM D1193, Type IV water. To obtain this 0.1% w/v solution, dissolve 0.025 g ± 0.001 g of dye in 25 mL ± 1 mL of ASTM D1193, Type IV water.

c. Fill a 1.5 mL micro centrifuge tube (vial) with the test solution. Add 2 to 4 drops of the dye (0.1% w/v) solution, close the vial, and shake vigorously.

d. Keep sample at test temperature minimum 8 hours prior to the test.

3.4.5 Runway Deicing/Anti-Icing Chemical Addition to Ice Surface

The adapted test support as prepared in 3.3.4 with glass test tubes containing ice samples, the test solution and the micro-pipette plastic tips shall be stored at the intended test temperature at least 10 hours prior to the test. The test support is adjusted in a horizontal position and the runway deicing/anti-icing chemical sample is added as follows:

For each test tube (typically four), measure and record the length M1 (within ±0.5 mm), corresponding to the length between the top of the glass test tube and the surface of the ice (see Table 1 and Figure 4). Using a micro-pipette, 25.0 µL ± 0.3 µL of test sample is discharged onto the ice surface of one glass test tube (do not "inject" the test solution into the ice layer). The timer is started after the addition of the test solution. Make sure that the pipettor is accurately calibrated before using. The penetration depth of the coloured test solution layer can be read using a micrometer or a rule. It is easier to view this front when the operator stands within 30 cm in front of the test support and have a horizontal view on the front. A light can be used behind the glass test tubes, to make the reading of the ice penetration front easier. At specified time intervals (currently 5, 10, and 30 minutes), measure and record the length M2 (within ±0.5 mm), corresponding to the length between the top of the glass test tube and the ice penetration front. Typical data recording is presented in Table 1.

Table 1 - Ice penetration measurements

Runway Deicing \ Anti-Icing Chemical Identification:					
Test Temperature (°C / °F):					
Length	Time (min)	Measurements (± 0.5 mm)			
		Test Tube #1	Test Tube #2	Test Tube #3	Test Tube #4
M1	0				
M2	5				
	10				
	30				